CLOSUP Working Paper Series
Number 43

January, 2020

California:
Landscape of Renewable Energy Policy

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This paper is available online at http://closup.umich.edu

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April 2019 (revised January 2020)

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Further reviewed and edited by Doug Noe in January 2020

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I. Introduction

Californians have a strong history of environmentalism and progressive energy policies, dating back to the days of the gold rush. Some have posited that Californians care so much about the environment because they have had so much to lose from its degradation and so much to gain from its preservation.[1] Perhaps the recent droughts and ensuing fires have given Californians the impetus to care even more about and alter their contribution to the global climate disaster. Over the last few decades, environmental concern, coupled with strong potential for renewable energy and high electricity prices, has contributed to significant renewable energy development and the establishment of aggressive renewable energy targets.[2] California is regarded as a national leader in renewable energy generation from solar, wind, geothermal, and biomass energy sources. Most California residents (across the political spectrum) support renewable electricity and the legislative mandates for them.[3] However, the state still has a long way to go to reach its goals. This paper discusses the current renewable energy policy landscape across California and explores potential opportunities for synthesis of state and local policies to bring about more efficient and effective adoption of renewable energy.

II. Background

Energy Mix in California

Unlike other states, California has not relied much on coal for in-state electrical generation over the last twenty years. As evidenced in **Figure 1**, it has instead increasingly relied on imports from out of state in order to meet its electricity demand. Its mix in 2017 was comprised of 14% coal sources, 10% natural gas, 9% hydro, 26% renewables, 10% nuclear, and 32% unspecified sources. Net imports in 1997 represented 23% of electricity generation, versus 29% in 2017. Another large change in the mix from 1997 to 2017 was related to renewables, which represented 9% of the mix in 1997 and 18% in 2017. Aligned with national trends of reduction in nuclear power, nuclear plants represented 16% of the generation in 1997 and only 6% in 2017. Natural gas and hydroelectric generation remained relatively consistent over the last twenty years.[4]

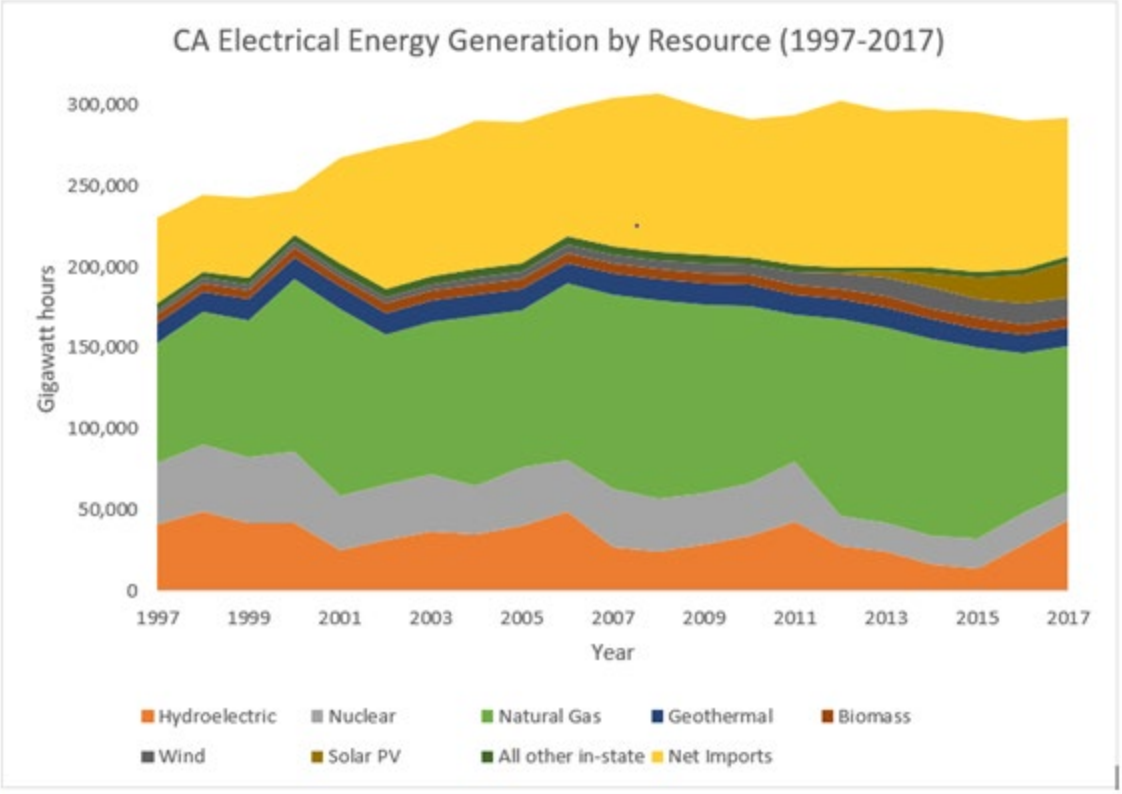


Figure 1: The breakdown of electrical energy generation by type in California in the last twenty years. Net imports are comprised mainly of coal, renewables, nuclear, and other unspecified sources, but the state is not able to provide a clear breakdown for every year. Derived from California Energy Commission data.[5]

While California (CA) is known for its progressive energy policies, it will have to make a lot of progress before it can fully decarbonize its electricity sector. As evidenced in **Appendix 1**, over 43% of the current electricity generation in the state comes from "non-clean" (i.e., fossil fuel-based) sources. In addition, 29% of total energy use in CA is derived from imports from other states, only 45% of which were from clean sources. To replace natural gas electricity, the Clean Air Task Force (a non-profit organization focused on reducing greenhouse gas [GHG] emissions) estimates that California will need to install "more than 200 times as much energy-storage capacity than it currently" had as of august 2018.[6] As of April 2019, the California Energy Commission, however, has approved three natural gas plants, which are currently under construction: the 558 MW Carlsbad Energy Center Project, the 939 MW Huntington Beach Energy Project, and the 1,040 MW Alamitos Energy Center. The justification is that natural gas plants can meet peak demand at times when renewables will not be able to produce as much as is needed. This will likely lead to further GHG emissions but could also allow for further penetration of renewables. The necessity of new natural gas plants has been called into question, though, as an investigation by the Los Angeles Times found that "the state is operating with an oversupply of electricity, driven largely by the construction of gas-fueled generating plants, leading to higher rates."[7] Regardless, CA has plans for many more wind and solar installations,

with 50% of electricity due to come from renewable resources by 2025, per the Renewable Portfolio Standard (RPS) mandates.[8]

California currently has six investor-owned utilities (IOUs), the largest of which are Pacific Gas and Electric Company (PG&E), which serves a large portion of northern California and accounted for 33% of electricity demand in 2014; Southern California Edison (SCE), which serves a large portion of southern California and accounted for 33% of electricity demand in 2014; and San Diego Gas & Electric (SDG&E), which mainly serves the area around San Diego and accounted for 7% of electricity demand in 2014. CA has around 50 publicly-owned utilities (POUs), the largest of which are the Los Angeles Department of Water & Power (LADWP), which accounted for 11% of electricity in 2014, and Sacramento Municipal Utility District (SMUD), accounting for 7% in 2014. California also has four rural electric cooperatives and three community choice aggregators.[9,10]

Current and Projected Electricity Demand

California's 2017 cumulative statewide electricity demand was 288,613 GWh, a large share (89.1%) of which was met from retail sources.[11] In the same year, noncoincident peak load (net of self-generation and demand response) was 60,713 MW. Statewide net summer installed capacity (76,414 MW) was thus adequate to meet demand and provide reserve margins. **Appendix 2** shows the cumulative 2017 electricity consumption by county. Expectedly, the most population-dense urban centers like Los Angeles and Orange counties were also the largest consumers of energy. In general, northern counties used lower quantities of electricity than those elsewhere in California.

Projected until 2030, both annual consumption and net load are expected to grow at average rates of 1.27% and 0.84% respectively.[12] These rising trends have been largely attributed to the increase in light duty electric vehicle (EV) penetration, higher consumption from the industrial (manufacturing) sector, and declining savings from energy efficiency programs.[13] In the same timeframe, reductions from voluntary demand response programs, wherein large customers shed their load at times of greatest demand (in return for lower tariffs) are projected to remain small (and flat), around 200 MW statewide.

Current and Projected Renewables Capacity

While natural gas dominates existing installed capacity (51.6%) as of 2018, the Diablo Canyon nuclear facility has California's largest nameplate rating (2.24 GW). Further, although none of the state's renewable generators feature in the top ten based on capacity, two of those happen to be pumped hydro storage plants. It is noteworthy that, in terms of energy generated, second to the Diablo Canyon was the Geysers geothermal field (a 1.5 GW geothermal electricity project in California's Mayacamas Mountains)[14]. Non-hydro renewables comprised roughly 26% of California's 2017 installed capacity. Of these sources, solar and wind dominated, with approximately 14% and 8% contributions respectively. This translated to about a third of the state's retail electricity sales coming from renewable sources.[15] Behind the meter (non-utility) solar generation for 2018 was estimated to be over 13,000 GWh, up 490% from 2013 (**Figure 2**).

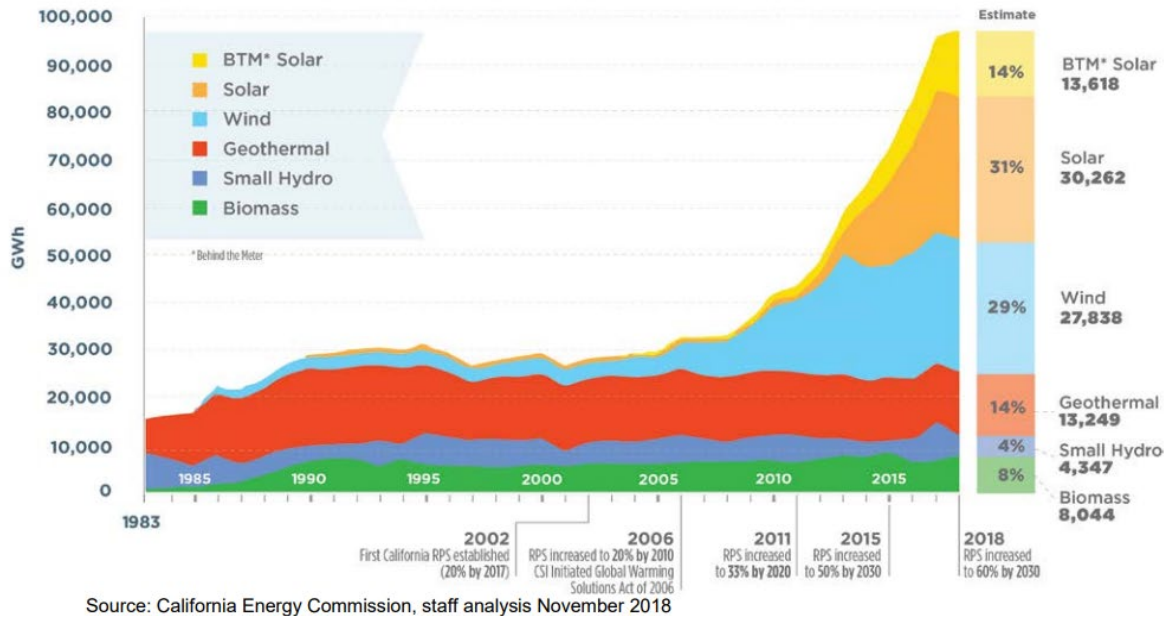


Figure 2: Total renewable generation serving California's load (by resource type), including imports.[16]

The penetration of renewables across the state is expected to grow, owing to aggressive policies like California's RPS, the Rooftop Solar Mandate, and the 100 Percent Clean Energy Act of 2018 (formerly SB-100), alongside the declining levelized costs of these technologies.[17] Of these, the 100 Percent Clean Energy Act will have perhaps the most profound impacts on renewables development, given that it specifies an ultimate target of 100% carbon-free electricity by 2045. See the *Climate Policies* section for details.

Meeting Demand with Renewables

A theoretical simulation suggests that if California were to transition its entire generation portfolio to renewables, the 2050 energy mix would be primarily comprised of utility-scale photovoltaics (PV; 27%), onshore wind (25%), concentrated solar power (CSP; 15%), offshore wind (10%), residential PV (7.5%) and geothermal (5%).[18] The 7.5% share of residential PV would equate to over 48,000 MW across 336 square kilometers of suitable rooftop area measured in 2012. An NREL study concurs, noting that their estimate of California's 76 GW total technical potential for rooftop solar PV is the highest of all states.[19] See *Rooftop Solar Mandate* section for details on the associated policy.

Renewable Energy Potential and Land Use

Broadly speaking, California has significant renewables potential, specifically for developing solar, wind, and geothermal sources. **Appendix 3** shows the solar resource availability across the state. Compared with **Appendix 2**, it is evident that regions of maximum load largely coincide with areas of greatest solar potential. While this favors small scale and rooftop PV development, it might warrant transmission and distribution (T&D) expansion for large utility-scale projects built outside of urban centers. The Mojave Desert area, encompassing

large tracts of publicly owned lands, has amongst the most valuable solar and wind resources statewide.[20] While most of this land is undeveloped, there is some activity around energy project development, tourism, military use, and cattle grazing. Collective efforts between public, private, and non-profit organizations have been undertaken to ensure native flora and fauna remain undisturbed when new renewables are built.[21] Located in the Mojave desert is the Ivanpah CSP project (377 MW).[22] Los Angeles County has set forth planning and zoning requirements for new build-outs; specifically, these requirements incentivize small-scale and structure-mounted projects and disincentivize utility-scale development. For instance, new projects in this region must ensure the preservation of identified Significant Ecological Areas (SEAs), such as the Antelope Valley, renowned for its Joshua tree woodlands.[23]

On the other hand, existing wind developments are mainly in six clusters, all relatively proximate to major cities. **Appendix 4** shows three of these major clusters around San Francisco, Santa Cruz, and Alameda counties.[24] Although Los Angeles County has since banned the development of utility-scale wind projects in unincorporated areas,[25] Alta, the largest installation (over 1.5 GW) in the state (and the second largest globally), is located in the Mojave desert close to metropolitan Los Angeles.[26]

Finally, while offshore wind development in California has economically been limited by water depth, in 2018 the Bureau of Ocean Management put out calls for development in three regions: Humboldt County, Morro Bay, and Diablo Canyon.[27] These areas have excellent resource availability (diurnally and annually) and are proximate to major load centers as well as existing power lines (**Appendix 5**). Hence, offshore wind could play a greater role in the coming decades.

Political, Economic and Demographic Landscape

California's most nationally influential industries are in agriculture, technology and energy. Its large agriculture and processing industry employs 7.3% of the state's labor force (within the private sector), predominantly in the north and central valleys of the state.[28] Historically, California has also been a leader in oil drilling along its coast, controlling the fourth-largest share of crude oil reserves in the U.S.[29] Though it is tough for California to meet its renewable energy demand in-state (due to the breadth of demand), the state is a large producer of renewable energy from solar, geothermal, and biomass energy sources.[30]

The federal government manages 45,864,800 acres in the state, representing nearly 46% of California's total acreage,[31] while the state's Department of Parks and Recreation manages approximately 1,358,400 acres of public lands.[32] Though public lands are located throughout the state, the largest swaths are along California's eastern border (**Appendix 6**).

Between the 2010 Census and 2015 estimates, the counties that have faced the most significant decline in population are located along the eastern border, with population decreases as great as 10.03% (Lassen County).[33] These declines in population coincided with the siting of more large-scale renewable developments in the region, though it is difficult to measure any degree of causality.[34] The overall state population, however, is expected to surpass 40 million

residents during 2019. As the majority of the population is concentrated in large cities, population increases are projected to continue this trend of high urban population density.[35]

Though California tends to vote for Democratic candidates, as its current gubernatorial administration and nearly three quarters of its legislature are represented by Democrats,[36] many counties of the state espouse conservative ideologies, especially in the northeast (**Appendix 7**). While the most recent gubernatorial election did not focus heavily on renewable energy, growing concerns over California's wildfires were relevant to candidates' positions on climate change and fire reduction strategies – with renewables (specifically distributed renewable energy) being regarded as a viable tool for fire prevention due to lower use of transmission lines.

III. Local Narratives

California widely publicizes its standing as a leader in renewable energy integration – with 29 cities having joined the government-run CCA, Clean Power Alliance, as an alternative to PG&E and Southern California Edison (SCE).[37] But such steadfast commitment has also been met with some local controversy.

Consumers largely support clean energy development, but there is a lack of clarity in how that occurs on a utility scale, as demonstrated, for example, by the residents of Claremont County, who fear they will face rate hikes as a result of their participation in the Clean Power Alliance (CPA).[38] Though consumers are offered rate options under CPA – ranging from 36% renewable sources to 50% renewable energy to 100% renewable energy[39] – some argue that this switch may be redundant, as SCE's power supply is already 32% renewable.[40]

There is a similar sentiment among residents of Ventura County, as the county's Board of Supervisors voted 3-2 to power government buildings with CPA's most expensive tier (100% renewable) – causing a 9% increase over the projected spending for eligible electrical bills in the fiscal year, despite being able to save money if they committed to a rate of 50% renewable energy.[41] There is not necessarily resistance to the incorporation of renewables, but there is significant concern that excess costs to commit to 100% clean energy would be better spent to help relieve financial and resource burdens of public hospitals.[42]

Concerns regarding renewables extend beyond the impact on utilities to the aesthetics of siting renewable facilities within communities. Siting renewable projects occurs at the county and municipal level, where many infrastructure projects (including renewables) are unwelcome.[43] This is especially prevalent the east of the state, where many viable regions for solar are also home to areas where there are significant protections of natural and recreational uses.[44]

However, many community members – even some within Claremont and Ventura counties – have a sense of duty to bear increased costs of renewables, as the costs of climate change are perceived to be far greater.[45] Others see such commitments as an opportunity to further strengthen the renewables industry as traditional, monopolistic utility business models become obsolete.[46]

Given the growing frequency and intensity of forest fires in the region, many consumers are projecting renewables as a necessary alternative in order to ensure fire prevention. Representatives of PG&E state that fire prevention would cost as much as $750 billion[47] – a price consumers are not willing to pay considering the public largely holds utility companies liable for recent deadly fires.[48] In looking toward forest fire prevention, many see renewables and distributed energy – such as microgrids – as a reliable alternative to reduce fire risk.[49] Microgrids (presumed to be sited within urban communities), coupled with California's offshore wind development projects, are regarded as a viable opportunity increasing local, secure electricity supplies amidst growing climate threats.[50]

IV. Climate Policies

Among a suite of policies that continue to shape the deployment of renewable energy technologies in California, three prominent policies are the Cap-and-Trade Program, the RPS, and the Rooftop Solar Mandate (part of the 2019 Building Energy Efficiency Standards). These policies impact renewables deployment either directly through their design or indirectly by intersecting with each other. It is estimated that between them, these policies could account for up to half of greenhouse gas (GHG) emissions reductions in the state between 2021 and 2030 (**Appendix 8**).[51]

Cap-and-Trade Program & Renewable Portfolio Standards (RPS)

Cap-and-trade introduction

California's Cap-and-Trade Program was first implemented and enforced by the California Air Resources Board (CARB) in 2013 as a strategy to reduce GHG emissions.[52] In 2014, California linked its program with similar initiatives in the Canadian provinces of Ontario and Quebec to unlock potentially greater economic efficiencies.

Passed as Assembly Bill (AB) 32, this program is a mechanism for California to reduce GHGs to 1990 levels by 2020 (a 15% reduction).[53] The updated policy, SB 32, requires California to reduce GHG emissions further: 40% below 1990 levels by 2030.[54] The Cap-and-Trade mechanism for achieving this level of decarbonization has also been extended (under AB 398).

This economy-wide program is designed to decrease GHG emissions while offering covered entities the flexibility to determine and implement the most cost-efficient pathways for reductions, tailored to their respective operations.[55] Specifically, this policy regulates emissions from 450 entities (across various sectors) who are responsible for a majority of the state's GHG inventory.[56] The program originally targeted electricity generators and large industrial facilities (like refineries and paper mills) that emitted 25,000 metric tons of carbon dioxide equivalents (MT CO_2e) or more annually. In 2015, Cap-and-Trade was expanded to include distributors of transportation fuels, natural gas, and other fuels. Importers of electricity from outside California are also subject to this policy.

Cap and trade details

The first element of this program is the 'cap,' or the emissions allowance threshold allocated to covered entities. This cap is dynamic in nature, decreasing each year from the previous limit. When this program was first initiated in 2013, the cap for a given entity was set at 2% below its 2012 emissions. Subsequent year-over-year declines in the cap have been around 3%. The second element of this program is the 'trade,' wherein an allowance (permit), equivalent to one metric ton of carbon dioxide equivalents, can be traded between the entities in markets. Once allocated, allowances can be purchased, sold, traded, or even banked (almost limitlessly) for future use. New allowances are auctioned by CARB twice quarterly, when a fixed number of permits are supplied through a competitive bidding process that allows for price discovery. To avoid handing down prices to ratepayers, electrical utilities are given free allowances, the value associated with which must be used to benefit customers. Note that participants in this program can also purchase offsets, or GHG reduction credits, from non-participant sectors (fulfilling up to 8% of allowance obligations).

The state also has a voluntary renewable electricity (VRE) program, wherein buyers of eligible voluntary renewable electricity can request the retirement of a specific fraction of their Cap-and-Trade allowances. The VRE Program allows for purchasing renewable electricity and renewable energy credits (RECs) that are not mandated by California's RPS.[57] Despite annual retirements each year, allowances made available in 2013 were not exhausted until 2017, indicating a surplus initial allocation of allowances. Program participants have included major electric utilities like Pacific Gas and Electric Company, San Diego Gas & Electric Company, and Southern California Edison.[58]

Cap-and-Trade also specifies a minimum (floor) permit price, currently \$14.5/MT CO_2e. **Figure 3** shows the 5-day moving average price of California Carbon Allowance Futures over time.[59] A decreasing trend is attributed to both an oversupply of allowances, and a cap that was, in hindsight, set too high relative to the actual (observed) decline in GHGs.

Figure 3: 5-day moving average price of California Carbon Allowance Futures over time.[60]

Another important facet of the Cap-and-Trade program is that auction revenues support AB 32 objectives. California's portion of the overall auction proceeds are deposited in the Greenhouse Gas Reduction Fund (GGRF), with investments made across a suite of programs in transportation and sustainable communities, clean energy and energy efficiency, and natural resources and waste diversion.[61] It is estimated that as of the end of 2017, revenues earmarked specifically for clean energy development had exceeded $5B.[62] As such, the state's carbon pricing program aids other environmental policies.

Despite the public's mostly neutral views on Cap-and-Trade, with one survey indicating 56% of adults and 49% of likely voters being supportive of this program,[63]there has also been pushback. Fundamental questions have been raised about whether the original target of reaching 1990 emissions by 2020 (corresponding to a 15% reduction) was aggressive enough to meet broader decarbonization goals.[64] Most recently, in 2017, the California Chamber of Commerce and Morning Star, a Woodland-based tomato processor, both appealed against the policy, claiming that it was an unconstitutional tax. However, the program was upheld 2-1 by the Third District Court of Appeal in Sacramento.[65]

Cap-and-trade versus RPS

Although the Cap-and-Trade policy does not directly involve mandates for renewable energy deployment, it shapes the markets that these technologies participate in. By pricing associated externalities, this policy differentiates energy sources that have traditionally been perceived as uniform (regardless of origin). Consequently, this program nudges electric utilities to shift towards lower-carbon (typically renewable) energy procurement and encourages the development of renewables.[66]

It is important here to further analyze the combined effects of California's Cap-and-Trade and RPS policies. The former is an explicit climate policy, while the latter is fundamentally an energy policy with associated climate impacts. Subsequently, both policies can help decarbonize the economy and change the energy mix, albeit to different extents. CARB calls for the SB 32 Cap-and-Trade to be the 'backstop' (background) policy driving complementary programs, including the RPS mandate.[67] In fact, the state expects other regulatory programs (such as RPS and CAFE) that address electricity and transportation emissions to yield most of the necessary decarbonization.[68]

Danny Cullenward, the California Senate representative to CARB's advisory committee on Cap-and-Trade, mentioned that California's GHG reductions over the past decade should be attributed primarily to the state's RPS, energy efficiency standards, and lower energy demand, with carbon pricing only accounting for a relatively small share (under 15%) of reductions. He went on to identify an oversupply and subsequent banking of unused allowances (from GHGs declining faster than expected) as a limiting factor hindering the full potential of this policy.[69] The state, however, expects Cap-and-Trade to play an increasing role in the coming decade, wherein this policy would account for 38% of required emissions reduction (up from about 15% for AB 32), with other regulatory programs tackling the remaining 62%.[70] A study from the Energy Institute at the University of Berkeley Haas School of Business supports this assertion,

indicating that the 2030 price of carbon in the state could rise to about \$52//MT CO_2e, wherein the output from GHG-intensive industries might become more price sensitive.[71]

Moving forward, there is concern about banked allocations hindering SB 32 goals. Some argue that if regulated entities comply via cheap stockpiled allowances rather than real emission reductions, emissions might not decline 40% by 2030. Contrarily, one study states that "planned abatement [until 2030] will not be sensitive to allowance prices." It remains to be seen how successful the future outcomes of Cap-and-Trade end up being.[72]

From a renewables deployment lens, Rachel Jiang of Bloomberg New Energy Finance noted that the Cap-and-Trade program extension is unlikely to have a significant additional effect on renewable build in California, with other direct measures such as the RPS continuing to play the predominant role. However, she also mentioned that the current carbon price does add roughly \$6/MWh (or 20%) to the daily average power price.[73] An RFF study, however, found that carbon prices are having smaller projected impacts on retail electricity prices than previously projected.[74] The study further noted that the most important factor in emissions reductions was a shift towards a generation mix with more renewables (from the RPS), and not carbon pricing itself. A study by Thurber, Davis, and Wolak simulated these policy interactions within competitive power markets. They found that high renewable energy shares from the state's RPS could push down carbon prices.[75]

RPS

It is imperative here to expand on the successful contribution of the RPS in statewide renewables deployment. California is on track to exceed its (former) 50% by 2030 renewables requirement; technology is available to help the grid operate with large shares of renewables, and the cost of investments needed to attain this target is coming down.[76] The 100 Percent Clean Energy Act (formerly SB 100) will further amplify renewables development, given that it specifies an ultimate target of 100% *carbon-free* electricity by 2045. While carbon-free sources encompass non-renewable technologies like nuclear and hydro as well, two intermediate targets – 50% renewable by 2026 and 60% renewable by 2030 (increasing the existing 50% by 2030 RPS requirement) – are also specified within SB 100. Both these intermediate targets are akin to amendments for existing RPS goals, despite being housed under the 100 Percent Clean Energy Act.[77] In doing so, this mandate offers flexibility in attaining carbon-reduction objectives without solely relying on a specific subset of technologies, while simultaneously promoting the growth of renewable energy systems. Specifically, this policy calls for "a diversified and balanced energy generation portfolio."[78] The fact that the 2045 target allows for utilizing other carbon-free sources, not limited to renewable generation, is contradicted by an op-ed in the Los Angeles Times, a prominent local newspaper, which incorrectly asserts that the (former) SB 100 is "unrealistic, based on land-use requirement calculations needed for *100 percent renewables."*[79] Further, there are explicit provisions in the act for considering both land use planning activities while developing in-state renewables, and sourcing out-of-state renewables (that count towards RPS requirements), if necessary. SB 100 also includes provisions that allow the CEC and the CPUC to waive certain compliance requirements for the state's utilities under a narrow set of

circumstances, including situations where meeting those requirements is not technically feasible or is too costly.

Rooftop Solar Mandate

California's Building Energy Efficiency Standards are designed to reduce wasteful, uneconomic, inefficient, or unnecessary consumption of energy and enhance outdoor and indoor environmental quality. They apply to newly constructed buildings and additions and alterations to existing buildings.[80] This policy targets continuous improvements and is subsequently updated every three years.[81] A 2019 update to the Standards mandates that all new homes under three stories high install solar panels starting 2020 and that solar PV systems be sized to net-out the annual energy usage of the dwelling.[82] This was motivated by the California Energy Commission (CEC) wanting to cut energy use in new homes by more than 50%. The ultimate goal of net-zero building energy use will be accomplished by coupling smart on-site generation with other key strategies, including updated thermal envelope standards, ventilation requirements, and (nonresidential) lighting requirements, as detailed in the Standards.[83]

Although this mandate will increase the prevalence of distributed solar generation (while also incentivizing BTM battery storage and demand response), the marginal value of solar installations to the system will vary depending on what generation it displaces. Presently, excess (net-metered) generation sent back to the grid is compensated at a significantly lower price than prevalent retail rates, despite being eligible for attribution to utilities' RPS requirements. However, panel rightsizing required by this mandate will likely avoid sustained overgeneration events.[12] Solar system sizes under the new rules are expected to range from 2.7 kW to 5.7 kW, lower than the current average 6.8 kW rooftop PV installation (retrofit) in California.[84] This will have twofold benefits for utilities: first, it will reduce balance-of-system costs, and second, it will reduce their net-metering costs. It is also estimated that the new rules could increase residential solar sales by 14% from 2020-23.[85] Thus, theoretically, the proposed policy design could satisfy both Californian utilities and the solar industry.[86]

While these Standards are updated cyclically, the rooftop solar mandate is unprecedented nationwide, not just in its requirements, but also in that building codes are not a typical avenue for solar policy. For developing an agreeable and effective mandate, the CEC performed a comprehensive analysis (starting in 2016) on the new rules, soliciting input from all relevant stakeholders, including utilities, homebuilders, solar companies, the lighting industry and others. Even so, there was pushback from the homebuilding industry, including players like the California Building Industry Association. To ameliorate concerns around conformity, the CEC reduced compliance costs by providing compliance credits for arbitrage from on-site battery storage and added flexibility measures to the rules. Further, the CEC estimates that the lifetime benefits from such a program will outweigh upfront costs. On average, this mandate will save roughly $40 per month per household, based on a 30-year mortgage. [87]

Given that the rooftop solar mandate has not come into effect yet, a few unknowns remain. Specifically, homes may not have to comply if they are deemed infeasible for rooftop solar (for example, shading impacts, remodeled units, and taller housing).[88] Although

community solar models could theoretically provide access to those unable to install individual rooftop PV, California's community solar supply is presently small (a few hundred megawatts).[89] Additionally, community solar projects do not qualify for net-metering credits. Next, homebuilders might also try to delay compliance by filing for their building permits earlier (under old rules), even if the dwelling is constructed after the Standards go into effect.[90] Finally, due to a lack of any empirical data from this downstream mandate, it is difficult to pinpoint how it could intersect with other policies. Dan Kammen of UC Berkeley speculates that revenues from Cap-and-Trade could help subsidize the upfront costs of panel installations for low-income families. His colleague Severin Borenstein, though, believes that the rooftop solar mandate is an economically inefficient model that could raise the cost of abating GHGs.[91] The ultimate story of how (well) this program materializes remains to be seen.

V. Taxation of Renewables

Renewable energy in California is subject to varying tax exclusions/exemptions depending on the resource/technology. Wind power is subject to property taxes whereas solar is excluded. There was a brief investment income tax credit in 2005 that lasted only one year and there have been no state-level income tax credits for renewables since. Recently, the California legislature passed a bill reducing sales and use taxes for renewables.

Property Taxation Exclusion – Solar Only

California law currently provides for an exclusion from property taxation for certain solar energy systems, which include solar heating systems, solar PV installations, and associated battery storage, at the residential, commercial, industrial, and utility levels.[92,93] The exemption was first created in 1980 through Proposition 7 (SCA 28), which resulted in amendments to the California Constitution and subsequent alteration of the Revenue and Taxation Code (Section 73).[94] The provision was scheduled to sunset in 2010, until the new AB 1451 was passed in 2008, extending the exclusion to 2024.[95,96]

The purpose of the exemption is to incentivize homeowners and businesses to install solar, making the panels subject to taxation only after the first sale of the property. Solar advocates argue that many homeowners would not build solar if it were subject to property taxes as the cost would be too high, especially in light of the recent mandate for rooftop solar.[97,98] A positive impact of the property tax exclusion on solar affordability and adoption appears to be supported by research, including a 2016 study by Lee, Hong, and Koo, which concluded that "Particularly, in Los Angeles... it is shown that capacity-based incentive savings due to state income tax credit and [property] tax exemption are considerably large."[99]

Critics of the policy, including the counties of Inyo and Riverside, argue that the exemption was never intended to apply to utility-scale solar installations and that they unfairly "bear the burden for providing services to these plants (e.g., police and roads), while receiving only little of the benefits therefrom."[100] Although Riverside County was unsuccessful in convincing the state Board of Equalization to change the policy to exclude utility-scale solar, it

enacted a fee of $450 per acre of land used by solar installations, which was later reduced to $150 after legal challenges.[101,102] Other local municipalities and counties have been assessing different fees, including "generally-applied development impact fees; environmental mitigation fees under the California Environmental Quality Act (CEQA); and project-specific fees enforced through a development agreement," all intended to make up for the fact that the municipalities are losing property tax revenue from these installations.[103] Other critics argue that the tax break unfairly benefits solar over wind, as wind is taxed and solar is not.[104] Refer to the *Siting* section of the report for further details regarding local vs state siting tensions.

Wind Property Taxation

Unlike solar, wind energy developments in California are subject to property taxes, capped at 1% of assessed value (ad valorem), although the effective rate depends on the county.[105,106,107] Wind properties are re-assessed every year at the market value, which declines annually due to depreciation.[108] Property tax revenue is allocated among municipalities in a county and is used mainly for primary, secondary, and community college education budgets, although this varies by location.[109] The state benefits from property taxes indirectly, as it needs to provide less aid to schools in communities that receive higher property taxes.[110] Wind projects have contributed to significant revenues for counties with large developments, leading to greater support than (untaxed) solar installations in some communities.[111]

Sales and Use Taxation Exemption – All Renewables

California has a state-wide sales and use tax (which differs by county but averages around 8.5% , reaching as high as 10.25% in parts of Los Angeles County), a majority of which goes to the state, with a smaller portion allocated to counties and cities (1.25%).[112,113,114,115] The 1.25% local tax is known as the Bradley-Burns Tax, with 1% going to the cities' and counties' general funds which can largely be used as desired and 0.25% going to the Local Transportation Fund (LTF).[116,117] Most of the state's portion (averaging 4.25%) goes to its general fund, with fractions also allocated to transportation, health, criminal justice, and social service programs.[118] Around 87% of the local sales tax goes to cities and 13% goes to counties.[119]

In July 2017, Governor Jerry Brown signed into law AB 398, which modified a sales and use tax exemption. The exemption, which pertains mostly to "clean" generation (solar, wind, geothermal, biomass etc.) but also includes combined heat and power coal/natural gas generators,[120] mainly benefits manufacturers but also extended to electrical generation: California's "partial sales and use tax exemption … reduces the total state and local combined sales tax," from 7.25% to 3.3125%.[121,122] This exemption is set to expire in 2030 but could likely lead to an increase in profitability for, and further adoption of, renewable projects . This exemption will effectively lower state sales tax revenue and probably face opposition, akin to the solar property tax exemption. Interestingly though, the exemption seemingly does not apply to the local portion of the sales tax (Bradley-Burns), and therefore it might not reduce local sales tax revenue and thus be more favorably perceived by counties than property tax exclusions.[123]

VI. Infrastructure Investment

Current Policies

California's abundance and diversity of natural resources are reflected in its current energy infrastructure, which spans the entire state and encompasses generation, transmission, and distribution of a wide range of electricity sources. The state's many different climate zones and biomes support this range: large rivers (especially in the northern part of the state and Sierra Nevada mountains) allow for the second-highest state hydroelectric generation in the country (13% of all hydropower generation in the U.S.).[124] Southern deserts are prime for utility-scale solar/solar thermal plants, and the Central Valley creates strong west to east winds that are captured by wind turbines in the foothills of the Sierra Nevada mountains.[125]

A variety of federal and state policies have led to California's current infrastructure investment. Famously outlined in the environmental journalism masterpiece *Cadillac Desert*, California was a main battleground in the hydropower construction war between the Army Corps of Engineers and the Bureau of Reclamation in post-New Deal America,[126] leading to the construction of 260 primary purpose hydroelectric dams in the state.[127] More recent state and federal policies – such as electricity deregulation in the late 1990s – shifted the state's electricity mix toward renewables,[128] and an increasing set of Renewable Portfolio Standards led to necessary increases in transmission capacity to handle greater renewable penetration over the past two decades.[129]

California is also the national leader for successful implementation of rooftop solar programs,[130] owing to ample sunshine, new progressive building codes/incentives,[131] and a long history of tax incentives and subsidies that have grown – and continue to grow – distributed solar in the state. The aforementioned post-Public Utility Regulatory Policies Act (PURPA) deregulation in the 1990s spurred the first incentives for the adoption of California rooftop solar by creating a Renewable Energy Program under the California Energy Commission,[132] and a series of programs since that time have provided incentives for small-scale solar generation.[133] The Self-Generation Incentive Program and Emerging Renewables Program were early forays in state-funded small-scale solar adoption, but it was the passage of the California Solar Initiative (CSI)[134] – run by the California Public Utilities Commission – that helped caused the state's massive solar expansion: rooftop solar capacity has increased a hundredfold since CSI went into effect in 2007, both because of the program and other external effects.[135] Finally, part of California's cap and trade program (established in 2013) revenues go toward funding single-family solar infrastructure for low-income households (i.e. photovoltaics and solar heating), as well as electric vehicle rebates that could be part of a large-scale future renewable energy storage solution.[136]

Recent Policy Changes/Looking Forward

The policy that will most impact California's future energy infrastructure is SB 100, the latest update (September 2018) to the state's RPS goals that aims to achieve 100% clean energy

by 2045.[137] Such an ambitious goal will be challenging, of course, and studies point to the massive buildup of transmission infrastructure required to meet it: one study estimates that a nationwide RPS of 80% would require a 100-fold increase in transmission capacity,[138] underlining the challenge that one of the country's largest states will face over the coming decades. Theoretical solutions to the infrastructure challenges presented by SB 100 include a network of high voltage direct current transmission lines between neighboring states to swap energy in real time (helping overcome intermittency issues),[139] and using electric vehicles as a storage option to help integrate renewables into the grid, as mentioned above.[140] Currently, the language of the bill's text is not very specific on how these kind of infrastructure challenges will be met for the timelines required by SB 100,[141] mostly amending the language of the Public Utilities Code to mandate utilities meeting the higher RPS goals.

However, one bill – AB 813 – aimed to lay the foundation for SB 100 grid improvements by creating a regional grid network/market, but it failed in the State Assembly shortly after passage of SB 100.[142] Labor unions put up a strong fight, arguing that the bill would cut jobs, while there was also concern among some lawmakers that regionalizing the grid would potentially allow shared governance of California's energy grid and risk intervention by conservatives in the federal government.[143]

Nevertheless, such a regional grid is widely considered to be necessary to meet the goals of SB 100, and it is unclear where the sheer quantity of transmission and distribution infrastructure will come from absent passage of a similar bill to AB 813. This is surely the reason why one of the lead authors of the bill (CA Assembly member Chris Holden) called it "valuable to future efforts":[144] the state seems to need a large grid consolidation/power market creation bill, and the power players know it. Aside from this particular avenue for transmission infrastructure progress, the California Public Utilities Commission has a robust Smart Grid plan,[145] though it currently attempts to offload much of the *distribution* build-up and modernization responsibility onto investor-owned utilities in the state by way of (again) fairly vague requirements in the Public Utilities Code. Transmission is another matter, as the California Independent System Operator (CAISO) releases a yearly Transmission Planning Process (TPP) report that forecasts energy needs and where new lines might be needed; many of these lines are constructed and paid for using a novel hybrid public-private partnership model.[146] Physical infrastructure/operations are often paid for and owned by the state, with the responsibility for upgrades often falling on utility companies; federal grants, especially in the wake of the 2008 recession, have also helped recent transmission build-out in the West.[147] Still, without a clear injection of large amounts of state funding into transmission projects – which does not clearly exist as of now – meeting the state's clean energy goals will likely prove difficult.

VII. Siting

Though Senate Bill 350 details California's overarching commitment to renewable investment and "clean energy" usage, enforcement of this policy for solar and wind projects requires coordination and support from local governments.[148] With regard to residential siting of

renewable projects, particularly rooftop solar, existing state laws of California require a city, county, or both, to administratively approve applications for installing solar energy systems through the issuance of permits.

While approval processes are vested with local governments, state-wide legislation has largely enabled greater capacities for small-scale renewable projects such as rooftop solar. Assembly Bill 1414, approved in October 2017, places a cap on solar permitting fees, allowing local municipalities greater flexibility to adjust fee levels for consumers – ultimately increasing residential accessibility to solar power and local and municipal financial capacities to site in residential areas.[149] As this statewide legislation increases municipal influence over projects, there has been little backlash from municipalities. Likewise, Assembly Bill 634 (approved in October 2017) expanded California's solar rights policies in that California homeowner associations (HOAs) are prohibited from imposing an outright ban on rooftop solar energy systems.[150] Though solar rights are largely expanded, the bill additionally requires that homeowners associations be given the authority to review and approve requests to install small-scale solar energy systems and to impose any additional requirements on the infrastructure as needed.[151] Thus decision-making powers of homeowners are not wholly usurped in processes that could otherwise be interpreted as undermining their authority.

Siting Large-Scale Renewable Projects

Under the purview of the California Energy Commission (CEC), developers of renewables (especially solar) with a generating capacity of 50MW or more must obtain licenses as a means of proof of siting approval in the municipality that approved their project.[152] Any developer qualifying as a public utility must also obtain a Certificate of Public Convenience and Necessity for the renewable project.[153] The CEC siting process evaluates proposed power projects based on the location and impacts on public health, safety, and the environment. Interveners (including local governments and the public) are formal participants in the CEC siting process, allowing for greater input to the CEC as they decide on whether to approve a permit or veto a process.[154]

California delegates the responsibilities of siting restrictions to county and municipal authorities. While counties largely have zoning policies that support California's Renewable Portfolio Standards, their degree of commitment to meeting the SB 350 mandate through large-scale solar and wind projects varies. San Diego County's Solar Energy Ordinance designates solar energy systems into two categories: onsite use and offsite use. Onsite use systems are permitted in any city zone, while offsite use systems require permits (10 acres or fewer: an Administrative Permit; greater than 10 acres: a Major Use Permit).[155] The city of Sacramento, meanwhile, differentiates accessory solar projects from commercial ones, designating the responsibility of permitting and siting accessory projects to their respective zoning districts.[156]

Since the implementation of California's Renewable Portfolio Standards program in 2002, the state has sited over 200 renewable energy generation projects. Almost three-quarters of these projects have been sited in counties with unemployment levels of at least 6% – bringing potential economic development to low-income communities, albeit to a potentially

disproportionate degree.[157] Though these are largely short-term employment opportunities, siting of more large-scale renewable projects are especially vital to electrical union workers, who often work on a freelance basis.[158] While residents are largely supportive of large-scale solar for perceived positive impacts such as increased property value and job opportunities, support for large-scale developments within their own community often fall along party lines, with Democrats more likely to support than Republicans.[159]

As local municipalities are more beholden to their voting constituents than they are to overarching state goals of "clean energy" dependence, large scale renewable projects are subject to strenuous rulings. Such is the case in the county of San Bernardino (a county that often flips between Democrat and Republican) where its Board of Supervisors, in a 4-1 vote[160], have banned approval for construction of large solar and wind farms that serve out-of-town utility customers. Projects that service local power needs of communities within the boundaries of the County's Community Plan remain eligible.[161] This ruling does not, however, disrupt projects currently in the permitting process (fourteen, as of February 2019).[162] The predominant concerns cited by locals related to the industrialization of rural desert communities, which could harm the aesthetic value of the landscape, as well as increased local vulnerability to larger dust storms.[163] While there are additional viable lands for renewables near the Central Valley and Imperial County, local sentiments inclined toward NIMBYism are not exclusive to the residents of San Bernardino.

Offshore Wind Siting Within Federal Waters

California, though theoretically suited for extensive offshore wind project siting, faces significant barriers in development not only from coastal municipalities, but also from federal entities such as the U.S. Navy. The Navy has already designated off-limits regions along California's central and southern coast, citing projects' potential hindrance of military operations (with some exceptions) (**Appendix 9**).[164]

Authority for siting in these regions is designated to the Bureau of Ocean Energy Management, which often heavily incorporates the input of Department of Defense entities. Such incorporation places additional siting potential of offshore wind projects into flux, as is seen in the cases of Morro Bay and Diablo Canyon (**Appendix 10**) – where coastal communities are ripe for a transition to renewables, given the retirement of nuclear power plants.[165]

VIII. Public Lands

Federal Public Lands

In December 2010, the Bureau of Land Management (BLM) and the Office of Energy Efficiency and Renewable Energy (EERE) developed a Programmatic Environmental Impact Statement (PEIS) as a means of evaluating the environmental impact of utility-scale solar development in the West.[166] Through this program, 11,067,366 acres of public land in California are eligible for right-of-way (ROW) application for renewable development, with an additional 1,766,543 acres of land being available specifically solar energy development.[167] Public land

designated for potential renewable development is concentrated into four zones: Imperial East (5,722 acres), Iron Mountain (106,522 acres), Pisgah (23,950 acres), and Riverside East (202,896 acres) (**Appendix 11**).[168]

The Public Land Renewable Energy Development Act of 2017 (US H.R. 825) established the Renewable Energy Resource Conservation Fund as a means of providing funding to federal, state and tribal agencies to assist with renewable energy projects on federal land. However, funds may only be allocated to the ecological restoration and protection of fish and wildlife habitats that are affected by renewable energy development projects and for the sake of preservation of the land's aesthetic for recreational public access.[169] Eligible projects would offer 25% of the leasing revenues from developers to counties and states, with an additional 25% of leasing revenues being returned to the Renewable Resource Conservation Fund.[170]

This act has, in turn, supported California's Desert Renewable Energy and Conservation Plan (DRECP), which limits renewable deployment on California's public lands in favor of environmental preservation.[171] A partnership between the BLM, the U.S. Fish and Wildlife Service, the CEC and the California Department of Fish and Wildlife (the "Renewable Energy Action Team") intends to balance renewable development interests with conservation interests across 22.5 million acres of the desert regions and adjacent lands with seven California counties (Imperial, Inyo, Kern, Los Angeles, Riverside, San Bernardino, and San Diego).[172] Renewable energy projects are only eligible to be leased on 7% of the lands.[173] However, by Executive Order, the Bureau of Land Management is now required to review conservation regulations that could impede energy development, thus opening the opportunity for an amendment process to the DRECP.[174]

Developer Permits for Siting on Federal Public Lands in California

If developers of solar thermal power generating facilities want to develop over 50 MW projects on public lands, they must submit their Applications for Certification (AFC) to the Bureau of Land Management and will be subject to the BLM's siting process. However, project review processes often work in tandem with the California Energy Commission (CEC) through the BLM's and CEC's "Memorandum of Understanding," which divides responsibilities of the review process between the two agencies. Approved projects receive a siting permit from the CEC, and an ROW authorization from the BLM.[175]

Renewable Development on Indigenous-Allocated Lands

Though indigenous communities have been granted sovereignty on 2% of federally recognized lands, the U.S. Department of Energy estimates that these lands could account for nearly 5% of the nation's renewable energy resources.[176] Akin to the siting of waste facilities, large-scale renewable projects may be sited on indigenous lands through partnerships and agreements with local indigenous authorities. On the Campo Indian Reservation (located within San Diego County), the Bureau of Indian Affairs and the Campo Band of Diegueno Mission Indians are in the process of conducting an environmental impact statement (EIS) evaluating the Campo Wind Energy Project.[177] These projects are, in part to meet U.S. energy needs, incentives

for indigenous communities, since they can offer potential economic development, increased revenues, and increased energy access.[178]

IX. California Public Utility Commissions Policies

The California PUC (CPUC) is responsible for regulating investor-owned electric and natural gas utilities in California and for implementing most laws passed by the state legislature related to electricity and utilities. The CPUC has been instrumental in ensuring California's transition to renewable energy through regulation and oversight in mainly the following areas: Greenhouse Gas Cap-and-Trade Program, Renewable Portfolio Standards (RPS), the Integrated Resource Plan (IRP), the California Solar Initiative (CSI), large-scale energy storage projects, a Distributed Energy Resource (DER) Action plan, PURPA feed-in tariff programs, and through providing regulatory assistance with various other renewable energy policies.

Greenhouse Gas Cap-and-Trade Program

The CPUC is responsible for overseeing the utilities' compliance with the Cap-and-Trade program and has decision-making power regarding the use of some of the funds raised from the program.[179] The commission also ensures that any rate increases related to the program are fair and reasonable. Refer to the *Climate Policies* section for further information regarding this program and uses of funds.

Renewable Portfolio Standards (RPS)

The CPUC is responsible for overseeing utilities' adherence to renewable portfolio standards, including the existing SB 350 (requiring 50% of the state's electricity to come from renewable power sources by 2030) and the newly adopted SB 100.[180,181] The CPUC has been monitoring load-serving entities (LSEs, i.e. utilities) to ensure that they are on track to achieve targets.[182] Refer to the *Climate Policies* section for details.

Integrated Resource Plan and Long-Term Procurement Plans (IRP-LTPP)

In 2018, the CPUC adopted an IRP process to "to ensure the electric sector is on track to help the state achieve its 2030 greenhouse gas (GHG) reduction target, at lowest possible cost, while maintaining electric service reliability and meeting other state goals."[183] Each of the state's utilities submitted procurement plans in August 2018 for how they expect to achieve the targets. CPUC is analyzing the plans in 2019 to ensure feasibility and reliability. PG&E's IRP details a large increase in solar development and energy storage by 2030, with very little increase in wind,[184] although it is unclear how the IRP will be affected by PG&E's recent bankruptcy filings (see the *PG&E Bankruptcy's Impact on Renewables in California* section for further discussion). Southern California Edison, on the other hand, called for a more even mix of wind, solar, and storage.[185] The PUC expects to issue a report at the end of 2019 (the Reference System Plan) that highlights the best ways for utilities to achieve the targets, alongside aspects of the IRP that the utilities will need to change.[186,187]

California Solar Initiative

The California Solar Initiative started in 2007 and provided rebates to California residents and businesses for installing solar PVs and solar water heaters on-site. It was funded by ratepayers and was overseen by the CPUC.[188] It contributed to approximately 1,800 MW of installed solar capacity before reaching its maximum enrollment in 2016. In its decision to not renew the program, the CPUC stated that solar prices dropped to the level that direct incentives were deemed no longer necessary.[189] The Initiative was largely deemed a success and was lauded for its volumetric reductions in incentives as more and more capacity was installed, bringing about a slow phase-out of the program, while solar installations continued to increase despite the credit phase-outs.[190]

Energy Storage

A key hurdle to achieving 100% renewable energy is the ability to store energy and use it when most needed, which often does not coincide with peak resource availability. The CPUC has been integral to the approval and oversight of energy storage projects in California, approving 1,620 MW of storage so far, including PG&E's decision to replace three natural gas plants in northern California with four energy storage projects.[191] In 2018, the CPUC also created rules for behind-the-meter (BTM) energy storage to ensure reliability and further adoption.[192] As mentioned in the *Integrated Resource Plan* section, the state's two largest utilities plan to expand energy storage greatly by 2030. With technologies becoming more affordable, energy storage may become very widespread and lead to further penetration of renewables, with the CPUC and its "California Energy Storage Roadmap" plan guiding the way.[193]

Distributed Energy Resource (DER) Action Plan

In 2016, the CPUC developed the Distributed Energy Resource (DER) Action Plan that outlines the best way to ensure safe and reliable penetration of distributed energy resources in the state.[194] While the plan mostly serves as a guide and does not entail a specific policy, it aims to provide clarity for proceedings going forward to lead to further DER adoption.[195] The plan will change with the new IRP requirements and will become more relevant as the requirement for all new homes to have rooftop solar becomes effective. In addition, the plan will change as the CPUC adapts to new programs related to PURPA.

PURPA - Renewable Market Adjusting Tariff (ReMAT) and the New QF SOC

The ReMAT program was a feed-in tariff program in California "for small renewable generators less than 3 MW in size" that ran from 2013 through 2017. CPUC chose to implement this program to comply with PURPA standards.[196] It allowed up to approximately 500 MW of small-scale electricity capacity (wind, solar, geothermal, and small hydro) to be delivered to the three large IOUs in the state by independent power producers that bid into an auction with the IOUs for power prices.[197,198] In December 2017, the US District Court in Northern California issued a decision that found that the CPUC violated PURPA in two ways: first, the cap on total capacity that was eligible for the program was not consistent with PURPA's "must-take"

policies, and second, Re-MAT's complex auction process "failed to comply with PURPA's definition of avoided costs" and prohibitively priced projects.[199] In response, in August 2018, the CPUC issued a proposal for a new program allowing for up to 20 MW projects to be entered into by any qualifying facility (QF) and fixing four price tiers to make it more feasible for Independent Power Producers (IPPs) to provide electricity at the "avoided cost" rate.[200] As of April 2019, the program is currently under comment period from affected parties and the PUC has not yet indicated when the program will commence.[201]

X. The PG&E Bankruptcy's Impact on Renewables in California

Given that Pacific Gas and Electric is the largest utility in the country[202] and filed for bankruptcy in January of 2019[203] after its infrastructure was likely the cause of the deadly November 2018 Camp Fire,[204] it is critical to examine the uncertainty – and its associated impact on renewable development – surrounding California's largest utility. There is concern among utility-scale renewable power suppliers who are in business with PG&E that bankruptcy will allow the utility to renegotiate or cancel contracts,[205] undercutting the state's renewable goals and injecting uncertainty into a business environment that is traditionally risk-averse. It is not clear whether those supplier renegotiations can actually take place as the utility would like, however, as Stanford Law's Marcus Cole notes; PG&E could be forced to pay those suppliers for breaching the contracts, as PG&E's filing is a "defensive" bankruptcy (meaning they still have money to operate and are filing for the purposes of liability protection).[206] The direct impact of the bankruptcy on distributed renewables has so far been small: household programs run by the utility such as net metering are protected under state law, and most other distributed renewable incentive programs are run and guaranteed by the state.[207]

Still, the bankruptcy of PG&E (its second in twenty years) has fueled calls to break up or bring the utility under state control,[208] an in-vogue idea in areas of the country with concerns about renewable energy and climate change.[209] Public ownership models for energy production and distribution – such as municipal utilities – have generally meant lower rates for consumers,[210] but proponents say they also could mean a faster shift toward renewables for localities and states that want to push for it. Instead of current mechanisms like RPS that force investor-owned utilities to add renewables to their energy mix, states could directly make the macro-level decisions on what kind of energy developments they pursue in the future.[211] However, one large state-owned utility might not be the best course of action for pushing the fastest possible renewable development: a recent study found that a higher number of smaller utilities in an area drove faster and stronger adoption of renewable energy policies than one large state-owned monopolistic utility, due to lower barriers to entry.[212] It remains to be seen how the PG&E Bankruptcy will affect renewables development in California, but recent calls for renewables associated with microgrids may lead to further adoption of smaller scale renewables to combat wildfires and reliability issues brought on by utilities.[213]

XI. Concluding Analysis

Explicit climate and energy policies play an overarching role in both decarbonizing California's economy and advancing renewables deployment within the state. Specifically, the RPS has been the single-most effective policy for encouraging renewables in California and will foreseeably continue to play that role in the coming decades. It is expected that the state will comfortably meet its 2030 RPS target as wholesale prices of renewables decline further and supporting policies ratchet up. In particular, the 100 Percent Clean Energy Act (SB100) sets out a long-term vision (until 2045) for decarbonizing the state's power sector. Potential concerns related to technical feasibility and the costs of a carbon-free grid are ameliorated by explicit provisions for waivers and out-of-state sourcing. Neither SB 100 nor the RPS policies specify technology-level requirements for fulfilling overall targets; i.e., they are agnostic between renewables and between zero-carbon systems. Regardless, extraneous factors and policies – some highlighted here – can (and likely will) lead to shifts in the state's generation portfolio, wherein solar outpaces wind developments in the coming years. On a distributed level, the rooftop solar mandate explicitly promotes the deployment of BTM PV panels. Although this mandate is yet to come into play, its design suggests that it would not increase overall system costs (from panels being rightsized), and in events of overgeneration, net-metered solar would count towards the RPS requirements (despite being compensated at inferior rates).

A supporting climate policy that has had positive (albeit small and indirect) impacts on renewables deployment is the state's Cap-and-Trade program. Fundamentally, the purpose of this program was not to drive renewables development but rather to be a backstop to complementary decarbonization policies such as the RPS. Although a high-enough carbon price can disincentivize carbon-intensive generators, potentially favoring renewables, the state has not seen such prices yet. In the future, however, it is expected that the role of Cap-and-Trade will grow, and if allowance prices also rise in conjunction, this may shift the state's energy portfolio even more towards renewables. For now, associated provisions such as the GGRF and VRE have likely aided renewables more than the carbon pricing element of the program itself. It is worth noting that if the state's retail electricity rates rise alongside the penetration of renewables, and if the carbon price stays close to the floor, it may disincentivize renewables. The plausibility of such an unwanted situation, however, seems low.

The California PUC has been instrumental in overseeing utilities' compliance with the RPS and Cap-and-Trade policies and has also been responsible for other important programs that have facilitated renewable energy development in the state, including the California Solar Initiative, energy storage mandates, approval of Integrated Resource Plans, and the Distributed Energy Resource Action plan. Arguably, these policies have created an overall environment that is conducive to renewables development in the state, leading to further adoption of renewables than may have otherwise been achieved by the state's investor-owned utilities. The CPUC's continued involvement in the RPS implementation and ancillary programs (including for both distributed and large-scale renewables) will be key to achieving further penetration of renewables in California.

An exploration of infrastructure programs is important to supplement this high-level view of California's climate and renewable energy policies. Two opposing infrastructure camps are evident in the state: those favoring a future of mostly in-state distributed generation infrastructure, and those favoring a more centralized utility-scale model with robust regional transmission networks. Although the distributed generation camp has won major victories – such as the aforementioned rooftop solar mandate – the passage of SB 100 (and its aggressive clean energy transition timelines) changes the complexion of the debate. Expert consensus is that expanding the California electric grid (and its Independent System Operator, or grid operator) to a regional system/market that includes neighboring states is the most economically efficient way to deal with the intersecting issues of aggressive RPS timelines, increasing renewable curtailment, and system reliability.[214] However, there are fears that a regional network could cause California to lose jobs in the renewables sector, cede strong state-level governance to regional or federal interests, and possibly introduce a dirtier energy mix into the state by linking with major coal-producing states such as Wyoming. Though the creation of a regional energy network/market seems likely inevitable given the sweeping requirements of SB 100, any mandate addressing regionalization will likely include protections and compromises that distributed generation advocates require to deal with the aforementioned fears.

While infrastructure decisions are often made at a state level, siting restriction responsibilities are definitively delegated to local counties and municipal authorities. Thus, decision-making processes regarding large-scale solar and wind are varied. In many ways, this process is beneficial as local communities and authorities can make decisions that are relevant and viable to their respective land management/use. Communities are incentivized with financial development opportunities and have the local knowledge and legitimacy to identify which areas within the county are technologically and socially viable for renewable projects. Despite associated financial incentives and jurisdictional authority, delegating to county authorities poses risks of NIMBYism, as local authorities can prevent large-scale renewable projects in their jurisdictions. As these circumstances have largely limited the incentives of siting large-scale solar and wind projects, there are even fewer incentives to engage in public lands siting as the decision-making processes of the Bureau of Land Management often prioritize conservation initiatives over renewable energy potential. Going forward, these issues need to be clarified for gaining alignment with RPS and SB 100 goals. The siting powers of local authorities in California leads to a potential for sweeping restrictions on renewables development, furthering the argument of those who advocate for a regional grid, as it may be unlikely that all of California's renewables needs can be met on California land/water.

The fact that California law excludes solar energy systems from property taxation has made solar installations more profitable and financially viable throughout the state and has further incentivized homeowners and businesses to install solar, most likely leading to an increase in solar in the state. Since California assesses property taxes on wind power, however, and the vast majority of the property tax revenues stay in the county, many county-level officials have looked on wind installations more favorably than they have on solar. The risks of

NIMBYism are also further exacerbated by these exemptions, as various counties are enacting hurdles for development of renewables, from solar-only development fees (Riverside County) to increased environmental compliance fees (Kern County) to outright bans of renewable energy development in certain areas (San Bernardino County), among others. Forcing utility-scale solar to be subject to property taxation may paradoxically facilitate further renewable energy adoption in the state, as municipalities and counties would most likely be more open to those projects if there is sufficient revenue from the projects that stays local.

In conclusion, despite California being a nationwide bastion of progressive policies for promoting renewables development and deployment, not all programs/policies that relate to renewables seem to be aligned with the state's overarching climate goals. **Figure 4** provides a qualitative depiction of the relative impacts of aforementioned policies on renewables development in the state.

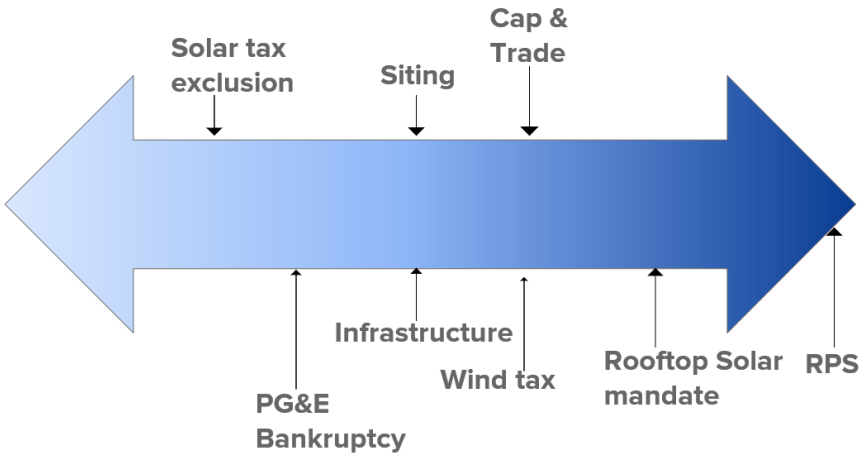


Figure 4: Relative impacts of various policies on renewables development in California. Far right indicates a positive impact; the middle is neutral; and the left is negative. Note that although the PG&E bankruptcy is not a state policy, it may have some detrimental impacts on renewables, especially if certain renewables contracts are not enforced.

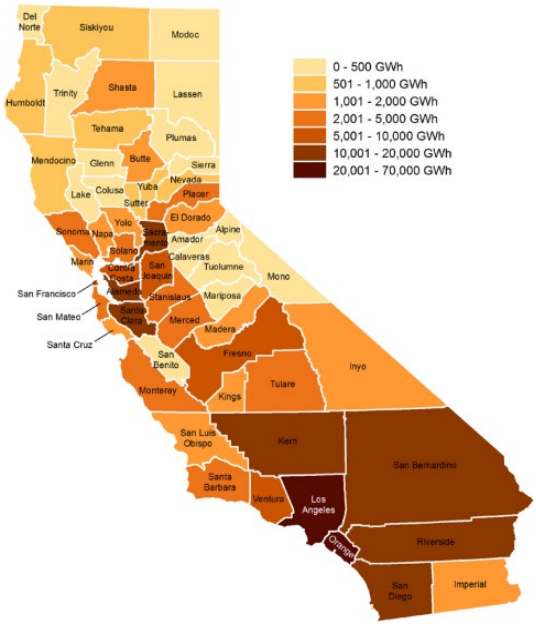
Although it is hard to balance several objectives and interests at differing levels of governance, proactive measures to ensure the mutual orientation of policies will enable California to continue on its path towards decarbonization in a just and cost-effective manner, thereby mitigating the impacts of climate change the state has already seen.

XII. Appendices

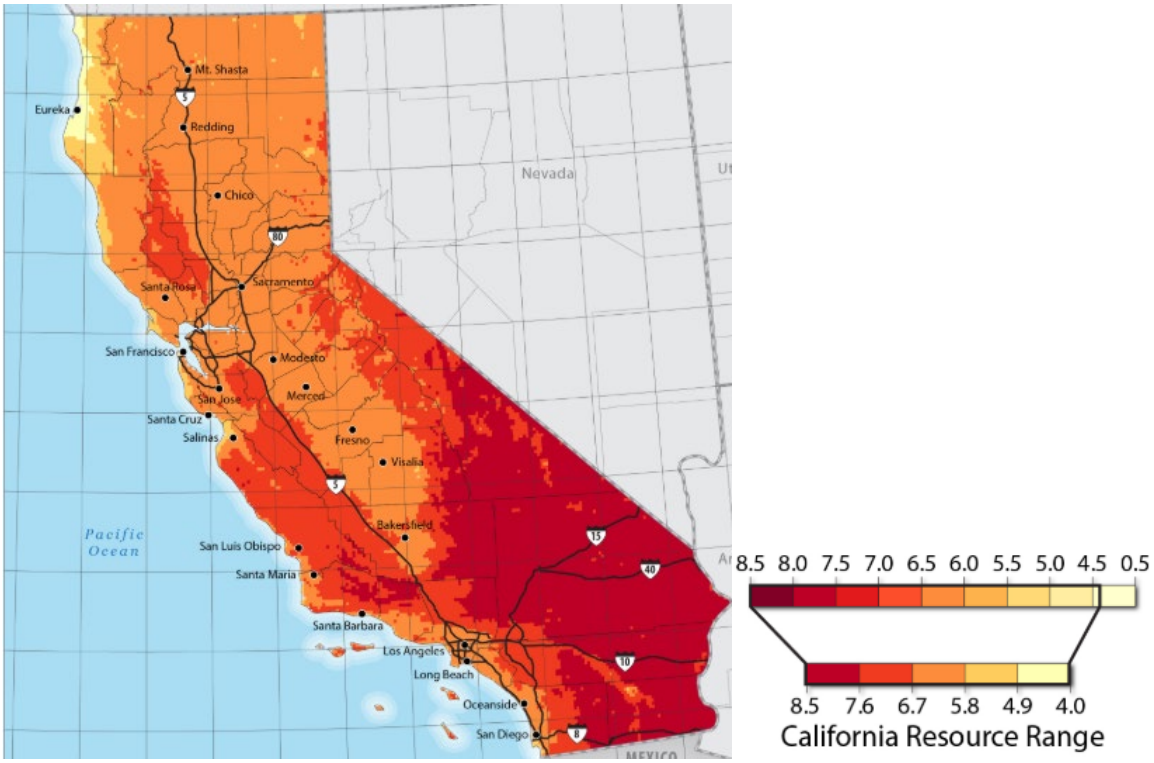
Appendix 1: California's electricity generation mix in 2017 based on generation and overall imports of energy.[215]

Fuel Type	California In-State Generation (GWh)	Percent of California In-State Generation	Northwest Imports (GWh)	Southwest Imports (GWh)	California Energy Mix (GWh)	California Power Mix
Coal	302	0.15%	409	11,364	12,075	4.13%
Large Hydro	36,920	17.89%	4,531	1,536	42,987	14.72%
Natural Gas	89,564	43.40%	46	8,705	98,315	33.67%
Nuclear	17,925	8.69%	0	8,594	26,519	9.08%
Oil	33	0.02%	0	0	33	0.01%
Other (Petroleum Coke/Waste Heat)	409	0.20%	0	0	409	0.14%
Renewables	61,183	29.65%	12,502	10,999	84,684	29.00%
Biomass	5,827	2.82%	1,015	32	6,874	2.35%
Geothermal	11,745	5.69%	23	937	12,705	4.35%
Small Hydro	6,413	3.11%	1,449	5	7,867	2.70%
Solar	24,331	11.79%	0	5,465	29,796	10.20%
Wind	12,867	6.24%	10,015	4,560	27,442	9.40%
Unspecified Sources of Power	N/A	N/A	22,385	4,632	27,017	9.25%
Total	206,336	100.00%	39,873	45,830	292,039	100.00%

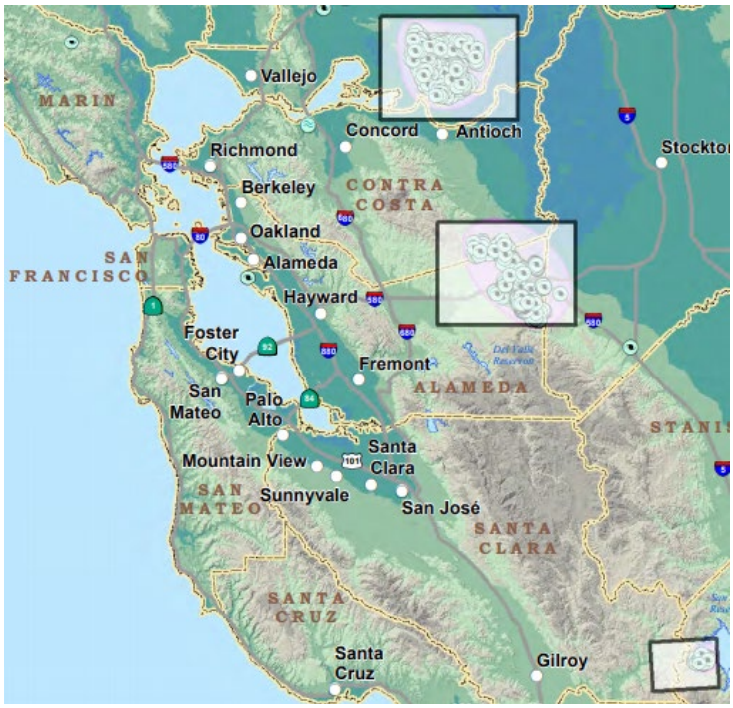
Appendix 2: California cumulative 2017 electricity consumption by county.



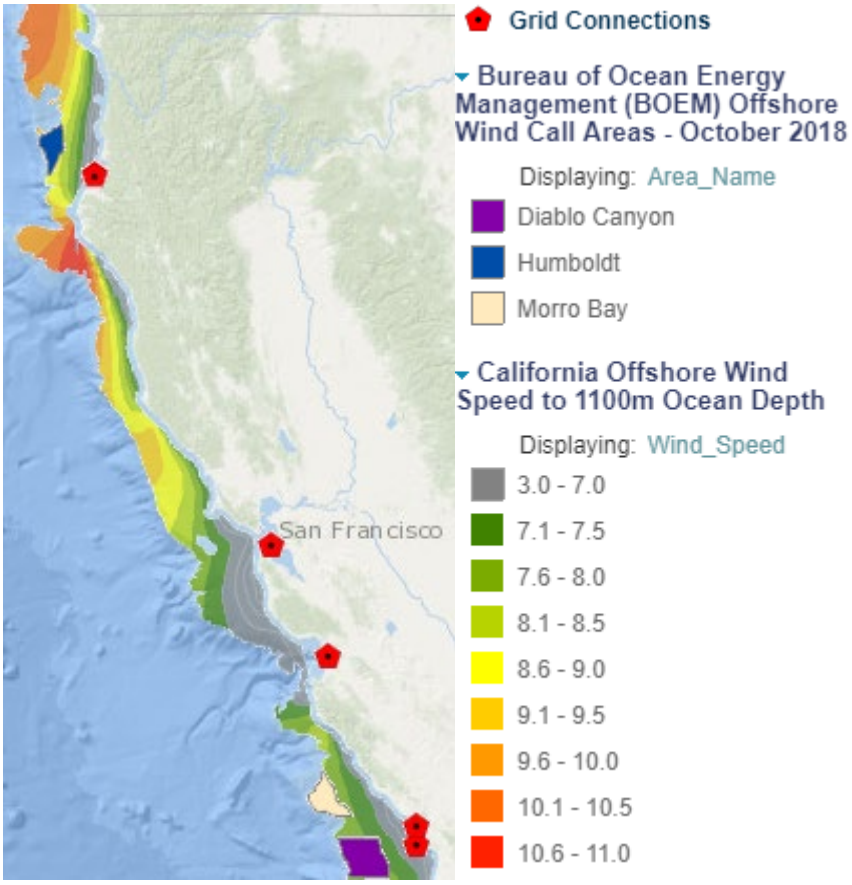
Appendix 3: Solar resource availability across California.[216]



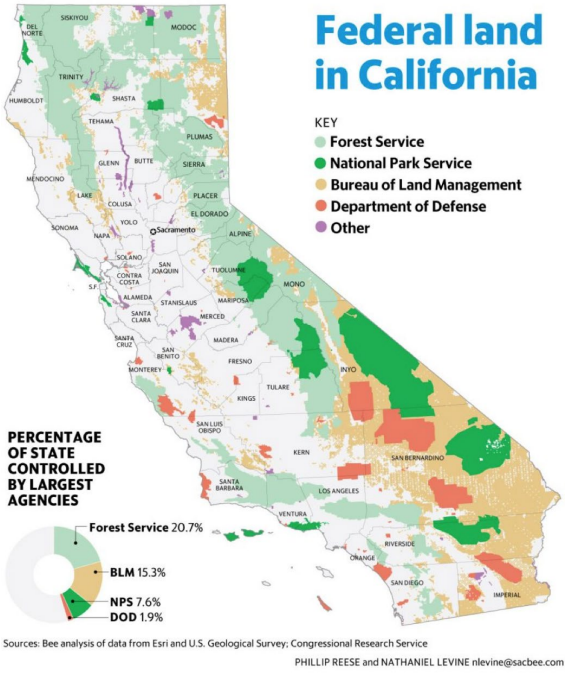
Appendix 4: Proximity of major onshore wind clusters to major load-centers.[217]



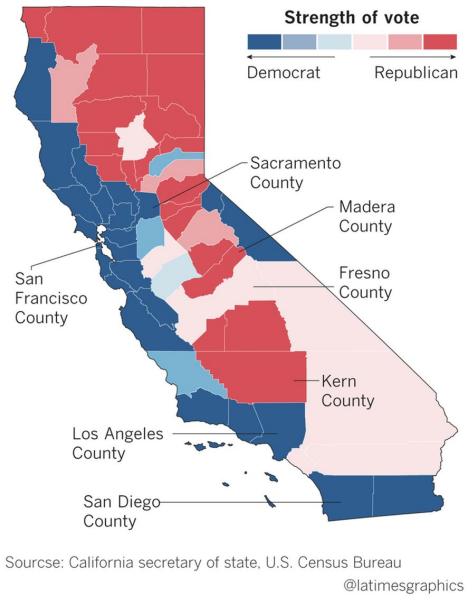
Appendix 5: California offshore wind potential.[218]



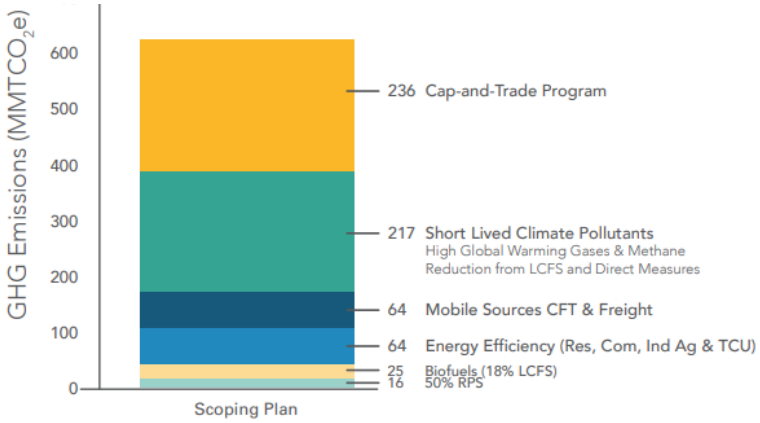
Appendix 6: Public lands of California, as designated by Federal Agency.[219]



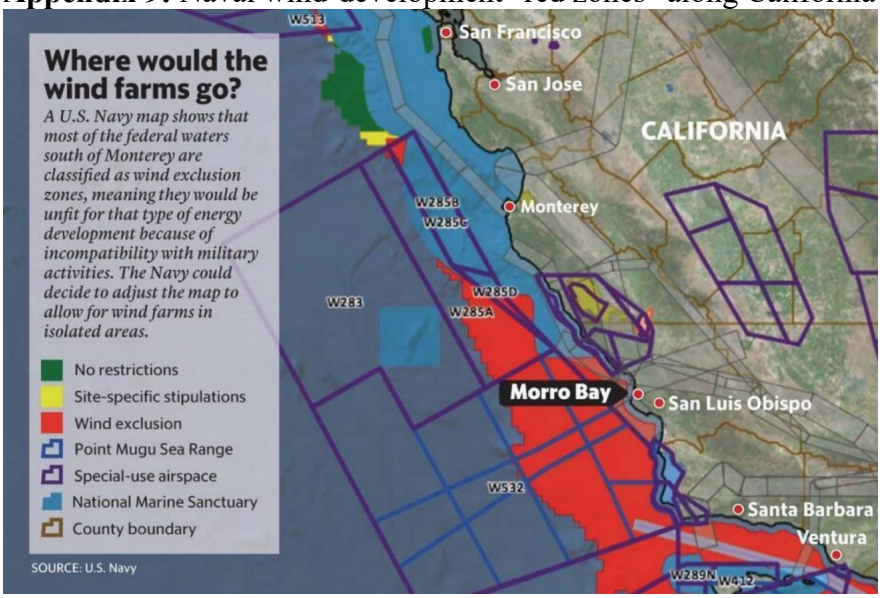
Appendix 7: 2018 midterm election results by county.



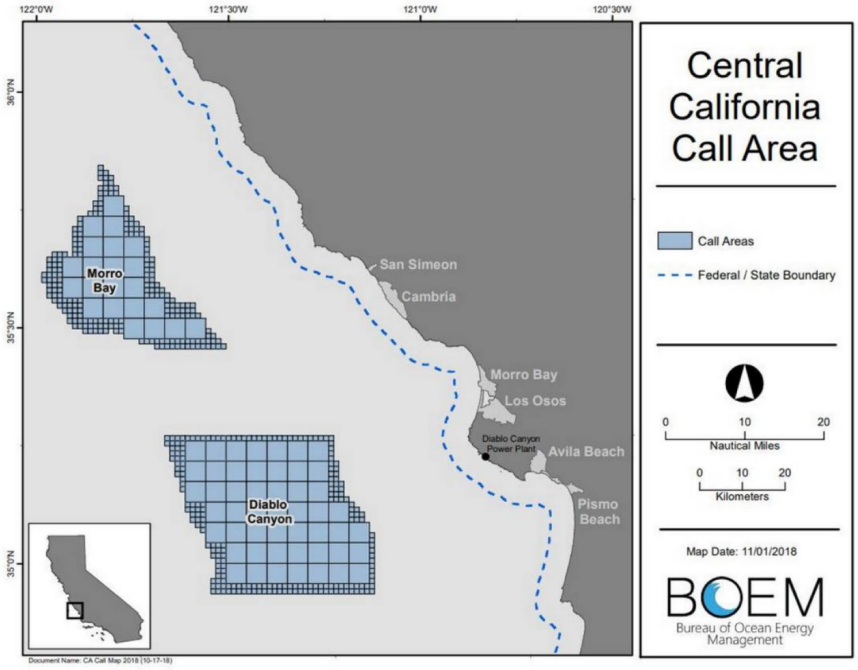
Appendix 8: California's 'Scoping Plan Scenario': Estimated cumulative GHG reductions by measure (2021–2030).[220]



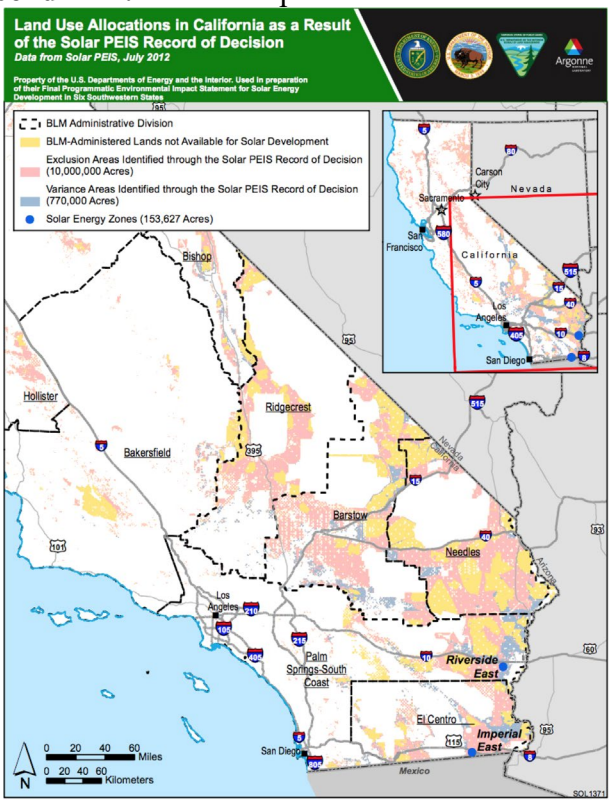
Appendix 9: Naval wind-development "red zones" along California's coast.[221]



Appendix 10: Proposed sites for the Morro Bay and Diablo Canyon wind farms.[222] Municipalities are thereby not beholden solely to the political clout of their constituents, but additionally to the concerns of the Department of Defense in developing large-scale projects in their efforts to meet the mandate of SB 350.



Appendix 11: California public land use allocations.[223]



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